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An Experimental Air Shipment of Fresh Fruits and Vegetables to the Middle East

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AN EXPERIMENTAL AIR SHIPMENT OF FRESH FRUITS AND VEGETABLES TO THE MIDDLE EAST

By William G. Kindya and Norman A. Carpenter 1/

ABSTRACT

The experiment was designed for the observation of handling procedures, equipment operation, personnel performance, and environmental conditions so that recommendations could be made to improve the efficiency of air transport of perishables to the Middle East. Four types of corrugated "pallet boxes" and various combinations of insulation and ice were tested.

KEYWORDS: Air transport, perishables, Middle East, pallet boxes.

INTRODUCTION

In recent years, the exposure of Western lifestyles to people in the Middle East has caused a change in lifestyles and increased the demand for Western goods and agricultural products. Large commercial transport aircraft can be used to supply some of the highly perishable agricultural products required to help satisfy this increasing demand.

A test shipment of fresh fruits and vegetables sent to Saudi Arabia was accompanied by two researchers who observed handling procedures and monitored product temperatures in transit. The test was conducted in cooperation with U.S. Armed Forces, which has personnel stationed in Saudi Arabia as advisors to the Saudi government.

Specific objectives of the test were to determine amounts of ice required for the transit period to eliminate re-icing in transit and to increase handling efficiency. This information can be used by air carriers of produce as a basis for planning nonrefrigerated, noncontainerized shipments of perishables to Middle East and other warm climate areas when transit conditions are similar to those of this test shipment.

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MATERIALS

Produce used in this test was purchased by the Office of Deputy Commander for Subsistence and by Commander, Subsistence Field Activities, the office responsible for worldwide management of Armed Forces' food products. The produce was purchased at a wholesale terminal market in Philadelphia, Pa., and transported to Camden, N.J., where it was briefly stored in a refrigerated warehouse until it was assembled into order lots for shipment to the airport. It was then shipped by military planes to its overseas destinations at military commissaries in Saudi Arabia. The history of the produce used in this shipment is not known before its purchase at the wholesale market in Philadelphia. Since this test was conducted during May, most of the produce shipped was grown in the Southern and Western parts of the United States. Therefore, up to 2 weeks could have elapsed from the time the produce was harvested until it was placed on the aircraft. The produce arrived at the warehouse assembly point at Camden, N.J., in commercial wholesale packaging units (fig. 1). At this point the produce, which was still in its wholesale packaging unit, was placed into experimental "pallet boxes" which were made of different materials for this test (figs. 2 and 3).

Figure 1.--Produce in wholesale packages stored in cold storage warehouse before shipment.

Figure 2.--Corrugated fiberboard regular slotted carton (RSC) pallet box being loaded with produce for air shipment to Saudi Arabia.

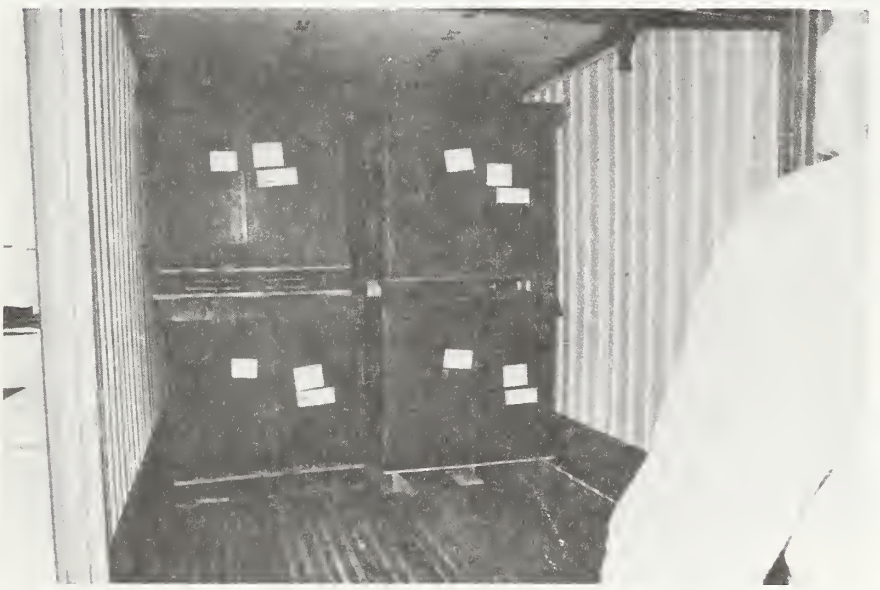

Figure 3.--Corrugated fiberboard sleeve and cap pallet boxes inside refrigerated trailer before shipment from cold storage warehouse to airport.

The four types of pallet boxes with their outside dimensions are:

(a) Triple-wall corrugated fiberboard regular slotted carton (RSC) pallet box, weather-resistant, 102 by 122 by 91 cm

(b) Triple-wall corrugated fiberboard sleeve, weather-resistant, 102 by 122 by 91 cm

(c) Triple-wall corrugated fiberboard sleeve, wax-impregnated, 102 by 122 by 91 cm

(d) Double-wall corrugated fiberboard sleeve, wax-impregnated, 102 by 122 by 91 cm.

The corrugated fiberboard sleeve-type pallet boxes were capped with double-wall corrugated fiberboard wax-impregnated caps 102 by 122 cm, with 15-cm flaps. A cap was also used as a bottom tray for the sleeve-type pallet boxes by placing it on a pallet and securing it to the pallet with staples. Some pallets were received from the manufacturer with these bottom trays already stapled to them. This greatly simplified the loading operation. The pallets, except for one, were wooden four-way entry pallets with top and bottom deckboards. The one exception was a pallet constructed with 12.7-mm-thick particle board top deck, nine polystyrene supports, and no bottom deck.

Table 1 gives the various combinations of insulation and ice which were tested. Sheets of expanded polystyrene insulation 12.7 mm and 25.4 mm thick were placed on the inside surfaces of selected pallet boxes.

A total of 24 pallet boxes were packed with produce for the test. Since this was a shipment of mixed produce, the produce was separated for packing into pallet boxes according to its sensitivity to transit temperatures. Separating these products was done primarily to minimize losses which might occur in transit due to overheating of the more perishable produce.

Ice was frozen at -26 ^{o}C in 22-kg blocks inside double plastic bags within single-strength corrugated fiberboard boxes. This packaging method is referred to as "bag-in-box." Packages of produce were placed in the pallet boxes until only enough room was left for the required amount of ice. Blocks of ice were then placed in the appropriate pallet box on top of the produce.

Thermistor temperature sensors were placed inside the pallet boxes to monitor and record air temperature during transit. Caps were then placed on sleeve-type pallet boxes and flaps secured on the RSC pallet boxes. Two polypropylene straps 12.7 mm wide were then applied to each pallet box to keep the box securely closed and firmly attached to the wooden pallet. Pallets were then loaded on a refrigerated truck and transported to Dover Air Force Base, Dover, Del.

HANDLING AT AIRPORT

The trip from the cold storage warehouse in Camden, N.J., to the airport in Dover, Del., took about 3 hours. The pallet boxes were unloaded from the refrigerated truck and placed in an unrefrigerated warehouse. Trucks with low clearance at the rear doors were inefficient to unload, since the double-stacked pallet boxes had to be broken down and handled individually. Forklifts used to unload the trucks were equipped to handle pallets stacked two high; therefore, only trailers with high rear door openings should have been used.

Inside the warehouse the pallet boxes were prepared for air shipment by unitizing the pallet boxes on aluminum aircraft pallets. Eight pallet boxes were placed on one aircraft pallet. The pallet boxes were stacked two high, then covered with plastic film, and finally strapped to the aircraft pallet with a nylon aircraft cargo retaining net (fig. 4). The prepared unitized loads were then placed in refrigerated storage to await aircraft loading the next day (fig. 5).

The perishables were held at the airport warehouse for 26 hours. Only 4 hours were actually spent in unloading the truck, assembling eight pallet boxes on each aircraft pallet, shrouding with plastic, netting units, placing on aircraft loaders, and loading the aircraft. Although some time cushion is necessary, improvements can be made in shortening the unused 22 hours.

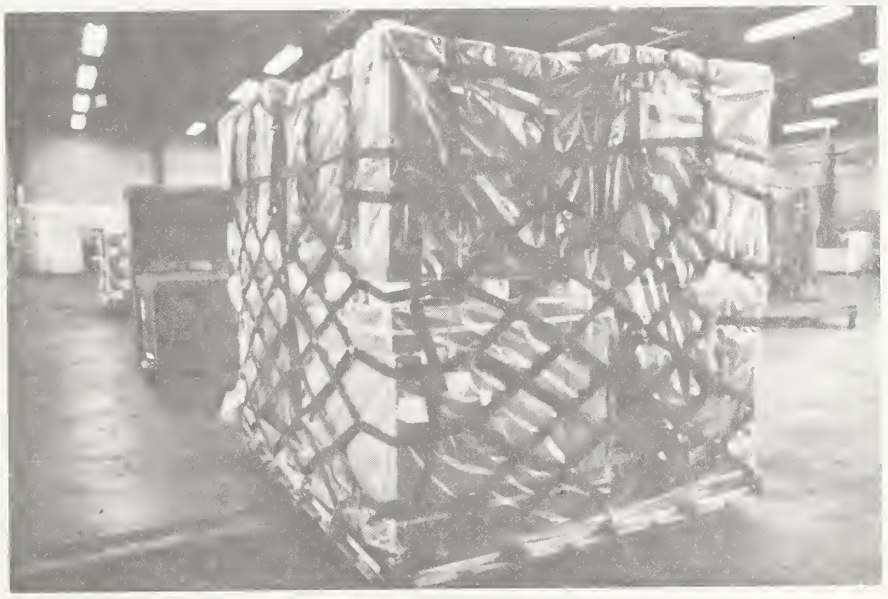

Figure 4.--Eight pallet boxes unitized on aircraft pallet. Pallet boxes are covered with plastic film for protection against the weather and strapped to the aircraft pallet with a nylon retaining net.

Table 1.--*Commodities and combinations of packaging, insulation, and ice used for transporting fresh produce by air from the United States to Saudi Arabia*

Pallet box					
Type 1/	Position 2/	Commodity	Insulation 3/	Blocks of ice 4/	Percent ice remaining 5/
a	bottom	cucumbers, cauliflower	25.4 mm partial	3	75
a	top	tomatoes, cauliflower	25.4 mm partial	2	50
a	bottom	lettuce, tomatoes	25.4 mm partial	1	50
a	bottom	tomatoes, radishes	12.7 mm partial	3	80
a	top	tomatoes	12.7 mm partial	2	70
a	top	cabbage, broccoli	12.7 mm partial	1	60
a	bottom	green peppers, onions, cucumbers	25.4 mm full	3	90
a	top	green peppers, cucumbers, radishes	25.4 mm full	2	80
a	bottom	broccoli, carrots	25.4 mm full	1	60
a	top	cantaloups, grapes, citrus	12.7 mm full	3	75
a	top	cantaloups, grapes, citrus	12.7 mm full	2	60
a	top	cabbage, apples, carrots	12.7 mm full	1	50
a	bottom	celery, corn, parsley	none	3	60
a	top	cabbage, carrots	none	2	70
a	bottom	apples	none	1	60
a	bottom	potatoes, Spanish onions	none	0	--
b	bottom	lettuce, apples	25.4 mm partial	2	75

Table 1.--*Commodities and combinations of packaging, insulation, and ice used for transporting fresh produce by air from the United States to Saudi Arabia--Continued*

Pallet box					
Type 1/	Position 2/	Commodity	Insulation 3/	Blocks of ice 4/	Percent ice remaining 5/
b	top	potatoes	25.4 mm partial	0	--
c	bottom	lettuce	none	2	70
d	top	lettuce, eggplant	25.4 mm full	3	75
d	top	lettuce	25.4 mm partial	2	75
d	bottom	lettuce, apples	25.4 mm partial	2	75
d	bottom	potatoes	none	0	--
d	top	potatoes	6/	3	90

1/ Types are: a = triple-wall corrugated fiberboard regular slotted carton pallet box, weather-resistant, 102 by 122 by 91 cm; b = triple-wall corrugated fiberboard sleeve, weather-resistant, 102 by 122 by 91 cm; c = triple-wall corrugated fiberboard sleeve, wax-impregnated, 102 by 122 by 91 cm; d = double-wall corrugated fiberboard sleeve, wax-impregnated, 102 by 122 by 91 cm.

2/ Position indicates whether pallet box was stacked on top or bottom when unitized on aircraft pallet.

3/ Full--consisted of sheets of polystyrene insulation placed on the entire inside surface of the sides, top, and bottom of the pallet boxes; partial--consisted of sheets of polystyrene insulation placed on approximately 75 percent of the inside surfaces of the sides, top, and bottom of the pallet boxes.

4/ Number of 22-kg blocks of ice packed in pallet box at cold storage warehouse.

5/ After arrival of produce at destination, Riyadh, Saudi Arabia.

6/ Insulation consisted of sleeve inserts constructed of 6.35-mm-thick polystyrene, laminated on both sides with kraft paper. 2 inserts were placed 1 within the other, then placed inside the pallet box. This provided 12.7 mm of polystyrene insulation on the inside surface of all 4 sides. 25.4-mm-thick polystyrene insulation was used on top and bottom of pallet box.

Figure 5.--Unitized pallet boxes being loaded on Air Force C-141 Starlifter aircraft for shipment to Saudi Arabia.

RE-ICING IN TRANSIT

The shipment arrived in Ramstein, Germany, after an 8-hour flight. Normally, the shipment would be re-iced at this time if more than a specified number of hours of transit time remains before it reaches its destination. One purpose of this test was to determine if re-icing in transit could be eliminated. Four pallet boxes were inspected at Ramstein. They contained enough ice for the remainder of the trip, so it was decided not to re-ice this shipment.

The shipment remained in Ramstein for 21 hours to allow for an aircraft crew rest. A crew rest of 18 hours is required after 8 hours of flying time. If a staged crew were utilized, the aircraft could be immediately refueled, checked for flight, and sent on its way without re-icing.

However, if the laborious and time-consuming re-icing operation is required, the following applies: Soon after the aircraft arrives at Ramstein, it is unloaded. The load is picked up at the aircraft and transported to a warehouse. The cargo net and plastic film shroud are then removed from each aircraft pallet load. The pallet boxes are moved, one by one, to the area of the cooler where ice is stored. Straps are removed, and the cap is taken off (or flaps of RSC box opened). The old ice is replaced with fresh ice, the cap (or flaps) repositioned, and the container restrapped with the only strapping material available at the re-icing station in Ramstein--31.75-mm galvanized steel strap, which is heavier than necessary and hard to work with.

Containers are moved across the warehouse again and reassembled onto aircraft pallets, which are again shrouded with plastic film and secured with cargo net. Pallets are loaded onto transporters and taken to the aircraft, loaded aboard the aircraft, and secured to the cargo deck. The aircraft loadmaster then repeats his load-and-balance calculations.

The entire operation requires one transporter driver, one forklift driver, two freight handlers, two people to restrap containers, two laborers, one supervisor, and one aircrew member. The re-icing operation takes up to 4 hours, and approximately 530 kg of ice are required.

ARRIVAL IN SAUDI ARABIA

The next intermediate stop after another 8-hour flight was Dhahran, Saudi Arabia. Here, the shipment was separated into three lots, each consisting of approximately one-third of the load. Each lot would be sent to a commissary in a different city, either Dhahran, Riyadh, or Jidda.

The Dhahran and Riyadh portions of the total shipment were unloaded at Dhahran; the remainder continued on the same aircraft to Jidda, Saudi Arabia. The Dhahran portion proceeded to the local commissary. The Riyadh portion, the 24 pallet boxes being tested, awaited pickup by a smaller aircraft for transporting to Riyadh.

Little time was lost in transferring cargo in Dhahran from one aircraft to another. The flight from Dhahran to Riyadh lasted 1 hour and 20 minutes. Unloading of the aircraft in Riyadh was extremely swift.

The produce was hauled by stake body truck from the airport to the commissary. There was no covering to protect the produce from the sun. The trip from the airport in Riyadh to the commissary took 3 hours because of delays at the airport and the small capacity of the truck. Normally, this trip should take less than an hour. Pallet loads were exposed to extreme heat from the sun during this portion of the trip--hot enough to melt the wax on the wax-impregnated pallet boxes and cause it to flow onto the produce packages. Bare metal cargo net clips were too hot to be touched.

Soon after arrival at the commissary, pallet loads were removed from the truck by forklift and placed inside the commissary warehouse for unloading, where it was a much cooler 35.6 ^{o}C (fig. 6). A crew quickly disassembled the pallet loads and stored the product in walk-in coolers.

OBSERVATIONS DURING TRANSIT

Observations during the loading operation at the cold storage warehouse, Camden, N.J., revealed:

1. The triple-wall weather-resistant RSC pallet boxes, because of their bulk and large bottom and top flaps, were unwieldy and difficult to assemble, handle, and load in comparison with sleeve-type pallet boxes.

Figure 6.--Unitized pallet boxes being unloaded from open flatbed transport truck by forklift at destination in Saudi Arabia.

2. Knock-down bottoms used with sleeve-type pallet boxes had to be folded along score lines, secured at the corners with staples, and attached to the pallet deckboards with staples by loading personnel. Therefore, the preassembled pallets with bottoms attached and corners prestapled at the point of manufacture greatly simplified loading.

3. The 12.7-mm strapping applied to hold the pallet boxes intact was sometimes fed through the pallet stringer cutouts instead of flush underneath the pallet top deckboards. This resulted in some breakage of strapping by forklift tangs.

The following observations were made during the re-icing procedure at Ramstein, Germany:

1. Air freight personnel stated that labels on pallet boxes are not always accurate, and some labels give re-icing instructions when the container doesn't contain any original ice.

2. Labels on this shipment did not show sufficient remaining ice-life time to destination; therefore, the pallet boxes were opened for re-icing. Original block ice would have been removed and replaced with 10-kg bags of crushed ice. In this instance, replacement of ice was waived by researchers since the heat-absorbing capacity of the remaining original block ice was considered superior to that of the crushed ice, and the block-ice carton was less susceptible to leakage than the crushed-ice bag.

3. Ice in containers other than those being tested had been placed in pallet boxes at random without considering the icing objective. One container opened for re-icing had four ice packs, all in one end of the pallet box. At times ice containers are placed on the bottom of the load. Air freight personnel had to completely unload the pallet box to remove old ice.

The following observations were made during unloading at destination:

1. All produce except cauliflower arrived in good condition. There was no damaged produce from crushing or handling during transit, and only cauliflower had deteriorated.

2. No icepack had thawed more than 50 percent. Some icepacks were as much as 90 percent frozen after 82 hours in transit.

3. The wax-impregnated pallet boxes that were exposed to direct sunlight for 4½ hours in Riyadh became soft and unstable when the wax melted and flowed down into the bottoms of the pallet boxes and onto some of the produce cartons.

4. Insulation was effective at keeping temperatures within reasonable limits inside the pallet boxes. Produce pulp temperatures at destination were 8.3 to 11.7 °C. Average air temperature inside pallet boxes and ambient-air temperature during transit are illustrated in figure 7.

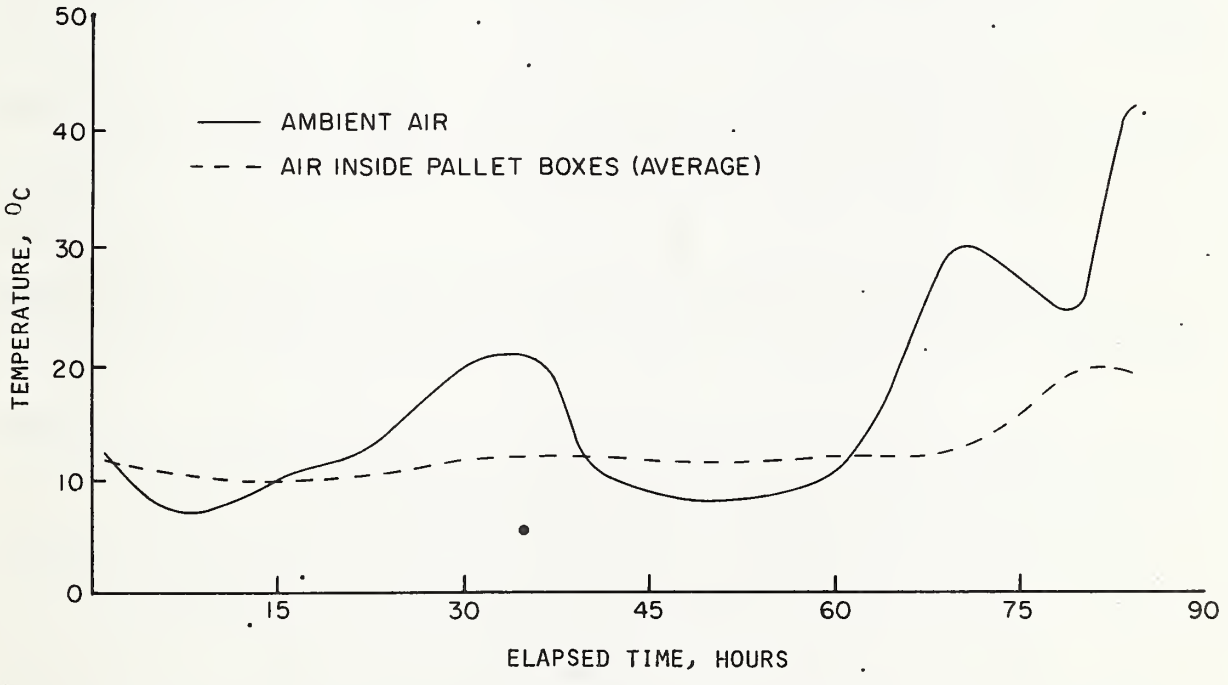

Figure 7.--Average air temperatures inside pallet boxes and ambient-air temperature during experimental test shipment of produce by aircraft from New Jersey to Saudi Arabia.

5. Sleeve-type containers were much easier to unpack than the RSC triple-wall containers. Sleeves can be slipped off the load and moved out of the way; persons unpacking the RSC boxes must lean over or climb into them.

6. The bag-in-box icepack served well in keeping the ice in place and avoiding leakage during transit.

CONSIDERATIONS

The following list of factors should be considered in shipping produce by air under conditions similar to those of this experimental test shipment:

1. Produce can be shipped year round by air in fiberboard pallet boxes; it is not necessary to incur the high cost of return shipments associated with returnable plastic, fiberglass, or aluminum containers.

2. Insulation should be used for all commodities (including potatoes) from April through October. If insulation is not used during cooler months, triple-wall sleeves (or boxes) should be used instead of the weaker double-wall containers.

3. Expendable pallets with wide, inflexible bottom deckboards or a full 102- by 122-cm bottom deck should be used.

4. Pallet boxes should be strapped with straps positioned through pallet stringers and flush against the underside of top deckboards of wooden pallet.

5. Trailers with a high rear door opening should be used for transport if loading or unloading crews can handle pallet boxes stacked two high.

6. Rigid foam should be used to provide additional strength to pallet boxes.

7. Commodities can be grouped into categories and designated as highly perishable, moderately perishable, slightly perishable, as well as commodities which need not be refrigerated except under the most severe conditions.

8. All ice should be packaged in bag-in-box cartons. Some improvements in heat transfer efficiency (such as holes in corrugated cardboard carton) could be considered. Ice should be placed inside pallet boxes, well distributed across top of load, and on side, not on end.

9. Re-icing time typed on shipping labels should be extended from the present 60 hours to 88 hours. This should eliminate re-icing en route.

10. Efficiencies in handling shipments should be pursued to reduce and possibly eliminate unrefrigerated storage time at intermediate points--in this case, Dover and Ramstein. Consideration should be given to using a staged crew at Ramstein instead of an 18-hour crew rest. These changes could eliminate all handling at Ramstein, save 24 to 40 hours transit time, and permit economies in icing and insulation requirements.

11. Shipments should be held in refrigerated storage, air-conditioned aircraft cargo compartments, or covered storage as much as possible. Shipments must absolutely be kept out of direct sunshine.

Table 2 suggests the number of blocks of ice (approximately 22 kg each) that should be placed within each container for air shipment to Saudi Arabia and other Mideast countries.

Table 2.--*Recommended icing quantities for shipment of fresh fruits and vegetables to Middle East destinations*

Month	Highly perishable	Moderately perishable	Slightly perishable	Bananas, potatoes
	Number of blocks of ice			
January	2	2	0	0
February	2	2	0	0
March	3	2	2	0
April 1/	3	2	2	0
May 1/	3	2	2	0
June 1/	4	3	2	2
July 1/	4	3	2	2
August 1/	4	3	2	2
September 1/	4	3	2	2
October 1/	3	2	2	0
November	3	2	2	0
December	2	2	0	0

1/ Fully insulated with the equivalent of 25.4-mm-thick expanded polystyrene insulation except highly perishable items which would require 38-mm insulation during June, July, and August.

CONCLUSIONS

Based on observations made during this study, it was concluded that fresh fruits and vegetables can be air shipped to overseas countries with extremely hot climates, such as Saudi Arabia, in fiberboard pallet boxes without significant deterioration or damage, provided exposure of produce to direct sunlight is kept to a minimum.

Ice in block form packaged in bag-in-box cartons is sufficiently leak-proof and has adequate heat-absorbing capacity to protect produce throughout an 82-hour trip when produce is packed in insulated pallet boxes.

Insulation is effective at protecting product from heat, extending useful life of ice, strengthening container walls, and protecting product from physical damage.

Re-icing en route can be eliminated except when unusual delays are encountered. Reduced transit time and improvements in handling procedures would reduce ice requirements suggested in table 2.

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